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Research Article

Assessment of watermelon production, marketing and consumption in the Central Rift Valley areas of Ethiopia

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Abstract: *Although the Central Rift Valley areas of Ethiopia are the dominant watermelon production, there is limited information on its production practices, market values and consumption. Hence, documenting the existing watermelon production experience is necessary to adopt watermelon farming in the new potential areas of the country including the Amhara region. Therefore, a survey using semi-structured questionnaires was performed to assess the production practices, market values, and consumption of watermelon in the Bora and Lumme districts of the Awash River basin in 2019. From 133, 47, and 147 questionnaires of producers, wholesalers/retailers, and consumers, 102, 43 and 137, respectively were valid to generate information. According to the responses, most watermelon has been produced under a receding farming system compared to irrigation and rain-fed conditions. Farmers allocate up to 5 ha farm size for watermelon production which implies watermelon farming in the areas is substantial. Farmers have gained a gross benefit of 30,000-400,000 ETB ha^{-1} with a productivity of 16 to 40 t ha^{-1}. Farmers implemented diverse agronomic practices such as spacing, seed and fertilizer rates, pesticide application, methods and frequency of irrigation. Such diverse agronomic practices in turn results in variations in yield and economic returns among farmers. Shortage of agricultural input, improper agronomic practices, lack of extension services, and market linkage were identified as major constraints of watermelon production in the survey areas. On the other hand, the availability of ample water sources, low capital investment, high demand for watermelon in the market, the proximity of the areas to central and roadside markets and relatively longer shelf-life of the fruit compared to other fresh fruits and vegetables were the major opportunities for the production of watermelon in the area. The return generated from watermelon marketing was considerable for women who were dominantly involving in the marketing segment. There was good experience for watermelon consumption in the survey areas which indicates the due attention of the society to the nutritional and health benefits of the crop. Generally, the high price and bulkiness of the fruit negatively affect the extent of marketing and consumption. The study confirmed that optimization of proper agronomic practices such as planting density, nutrient management, integrated pest management and close involvement of stakeholders throughout the value chain is vital to exploit the potential benefit of watermelon thereby improving the livelihoods of the smallholder farmers in the study area and other areas where watermelon production is emerging.*

Keywords: Central Rift Valley**;** Fruit size preference; Fruit quality attributes, Income generation
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1. Introduction

Watermelon (*Citrullus lanatus* [Thunb.] Matsum. & Nakai) is a Cucurbitacea family grown in the tropical and subtropical regions of the world (Parmar *et al.*, 2013; Urrutia *et al*., 2014). It is mostly grown for fresh consumption, processed products like sweet and canned slices (Urrutia *et al.*, 2014; Hien and Tung, 2006). Watermelon is a common crop in rural, urban and peri-urban areas of Asia with high accessibility to both rich and poor people (Webber *et al.*, 2019). Generally, watermelon varieties fall into three broad categories based on how the seeds are developed. These are open-pollinated, F-1 hybrid, and triploid seedless varieties (Alfa-Nla, 2014).

Due to the increasing demand, the production of watermelon has been continuously increased worldwide (Popescu, 2012). According to FAO (2019), the world production of watermelon increased from 91,507,308 in 2009 to 100,414,933 tons in 2019. This increasing trend is because of good income generation capacity compared to other annual crops. In this regard, Hien and Tung (2006) reported the shifting of rice-producing farmers to watermelon production. According to Alfa-Nla (2014), watermelon is produced predominantly by small-scale farmers while its marketing is mostly dominated by females (Kainga, 2013; Ekerete and Asa, 2014). Watermelon production is generally profitable compared to hot pepper as indicated by Baba *et al*. (2014) where net farm income for watermelon was ₦ 30, 946 while that of pepper was ₦ 19, 592 ha^{-1}. Similarly, Namdari (2011) estimated the cost-benefit ratio of 2.61 and 2.06 for high and low levels of watermelon production technologies, respectively in Iran.

Although watermelon production has increased in different countries of Africa in recent years, it has been constrained by various problems including high input costs, inappropriate agronomic practices, high incidence of pests, high transport costs, postharvest loss, natural disasters and lack of credit facilities (Alfa-Nla, 2014; Ekerete and Asa, 2014; Odinwa *et al*.,2015; Adojutelegan *et al.*, 2016; Sarker *et al.*, 2017). Moreover, low yield and fruit quality are the characteristics of the watermelon industry in developing countries (Gichimu *et al.*, 2014). According to Afolabi (2004), fruit quality and maturity are the prime importance in watermelon marketing followed by synchronization of the local harvesting time and time of shortfall in supply. Fruit quality attributes, availability in the supply chain, marketing channel, consumer preference, market information, and cropping calendar may influence the demand for watermelon (Zhou, 2011). The demand for watermelon is traditionally increased when the weather conditions especially temperature increase (USAID, 2008).

The dominant watermelon production area in Ethiopia is located in the Central Rift Valley around the Lake areas of Koka in Ethiopia where it was first introduced in late 1950. Although quite good market demand and allocation of reasonable farmland, the productivity and quality of watermelon produced in the country is generally low. For instance, the minimum soluble solids content (TSS) of the fruit should be more than 9% by world standard (Zhang, 2009). Whereas it is less than 6% of TSS in Ethiopia (Tigist Samuel, 2016). It is associated with poor agronomic practices, high postharvest loss, and a lack of appropriate varieties (Mekonnen, 2014). Moreover, the crop has experienced little expansion to other parts of the country. The Central Statistical Agency of Ethiopia as well as FAOSTA did not consider the production and productivity of watermelon in Ethiopia in their database. This indicates that the crop is neglected and considered an orphan crop.

Assessment of the current production, marketing and consumption practices of watermelon is quite necessary for the improvement of production, productivity and quality in major production areas as well as for the adoption of the crop in other suitable areas of the country. Therefore, the objective of the study is to have insights and information on the current production practices, constraints and opportunities of the crop to improve yield, quality and profitability of the watermelon industry in the country. The results of the present study also establish a baseline for future research works in the area of production, marketing and postharvest losses

as well as introducing the crop to new production areas of Ethiopia.

2. Methodology

2.1. Description of the study areas

The study was conducted in 2019 starting from the production area, which is in the Central Rift Valley in Ethiopia to the main fruit and vegetable marketing centre (*Atikilit tera*) in Addis Ababa, Ethiopia. Bora and Lumme districts of Oromia were selected purposively as they are the dominant watermelon production areas in Central Rift Valley. Doddo-Wodera, Gora-Geremeji, Laffissa, and Malimma-Beri kebeles from Bora district and Koka kebele from Lumme district were purposively selected in consultation with the respective district agricultural offices (Figure 1).

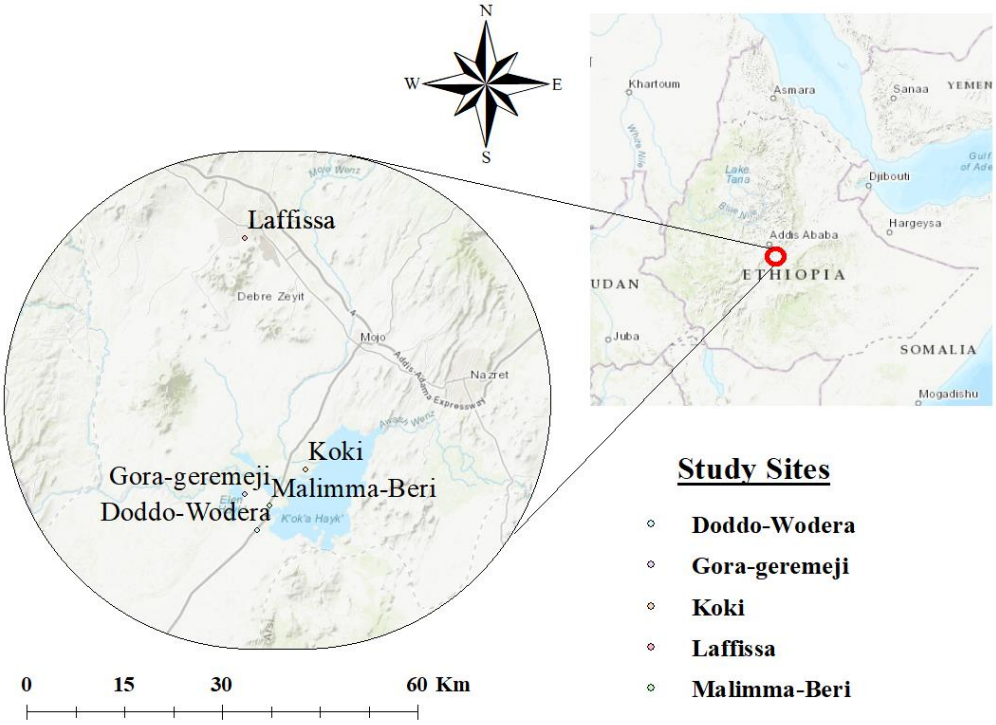

Figure 1: Map of the survey areas

2.2. Sampling procedure and sample size

The simplified formula of Yamane (1965) with a 95% confidence level was used to determine the sample sizes of the study having a finite population.

$$n = \frac{N}{1 + N(e^2)} \quad [1]$$

Where, n = the sample size; N = the population size; e = the level of precision

According to the Bora District Agriculture Office, about 40-60 individual farmers have been producing watermelon annually in each kebeles of the Bora and Lumme districts. Therefore, 200 farmers were considered as the total population size. Based on the above formula, 133 sample sizes of watermelon producers were interviewed.

Furthermore, to determine the sample size of traders and consumers involved in the roadside market around Koka and Addis Ababa as an infinite number of populations, the formula of Kothari (2004) was used.

$$n = \frac{Z^2 p\ q}{E^2} \quad [2]$$

Where, Z = the value from the Z table at 95% confidence level and 0.5% error = 1.96

p = % of travelers and residents who may buy watermelon from Koka roadside market and

Addis Ababa market (considered as the consumer).

q = (1-p)

E = the maximum allowance for error between population mean and sample mean.

According to the formula described above, 72 consumers from each of Koka and Addis Ababa markets were interviewed.

2.3. Data collection

Qualitative and quantitative primary data were collected using semi-structured questionnaires from 133 randomly selected smallholder producers, 47 roadside retailers & wholesalers and 147 consumers at Koka and in Addis Ababa. Among these, survey questionnaires 102, 43 and 137 from producers, roadside retailers and wholesalers and, consumers, respectively were valid and used for data analysis. Before conducting the survey, the questionnaires were pre-tested and subjected to improvement accordingly. Key Informant Interviews (KIIs) were also held with staff of the respective district office of agriculture and Melkassa Agricultural Research Center to triangulate the data obtained from the survey.

To examine the suitability of the surveyed areas for watermelon production, soil physical and chemical properties were analyzed. For that purpose, soil samples were taken from randomly selected farms with a soil auger at a depth of 25 cm and analyzed at Adet Agricultural Research Center Soil Laboratory according to the standard producers (Table 1).

Table 1: Soil fertility status of the survey areas

Soil characteristics	Locations					Rating	Reference
	Doddo-Wodera	Gora-Geremeji	Laffissa-Geremeji	Malima-Beri	Koka		
pH	7.9	7.51	7.62	7.2	7.9	high	Sahlemedhin Sertsu and Taye Bekele (2000)
ECE (mS cm^{-1})	225	111.3	133	173	163	strongly saline	Sahlemedhin Sertsu and Taye Bekele (2000)
OM (%)	0.96	1.61	1.63	1.57	1.57		Nelson and Sommers, (1982)
N (%)	0.096	0.105	0.103	0.158	0.092	low	Bremner and Mulvaney (1982)
CEC (Cmol+ kg^{-1})	33.92*	53.26**	50.32**	39.42*	64.08**		Chapman (1965)
Available P (meq/100g soil)	11.46	12.78	15.19	10.43	11.46	medium	Nelson and Sommers (1982)
Clay (%)	11	28	30	25	38		Sahlemedhin Sertsu and Taye Bekele (2000)
Silt (%)	41	62	60	59	52		
Sand (%)	48	10	10	16	10		
Texture	Loam	Silt-clay-loam	Silt-clay-loam	Silt-loam	Silt-clay-loam		

* = high; ** = very high

2.4. Data analysis

The data were analyzed using descriptive statistics with SPSS 16.0 version. Frequency and percentage were used to present nominal or categorical data for qualitative variables. The central tendencies such as mean, maximum, and minimum values were used to present interval or continuous data for quantitative variables.

3. Results and Discussion

3.1. Demography of the respondents

The demographic characteristics of the respondents such as sex, marital status, and education are presented in Table 2. In terms of sex, the majority of the producers were male-headed households while female-headed households were more likely involved in marketing and consumption in the value chain of watermelon. Similar sex distribution of watermelon farming and trading in different areas of Nigeria was reported by Otunaiya and Adedeji (2014), Baba *et al*. (2014), and Adeoye *et al*. (2011) that watermelon-producing households are predominantly male-headed. Ekerete and Asa (2014) and Kassali *et al*. (2015) also reported similar results where about 53% and 60% of watermelon traders were female-headed households, respectively.

Better educational level was observed in consumers compared to producers and traders. According to Oduro-ofori *et al*. (2014) as the education level increase, output increases. The authors confirmed that secondary school education has the highest return on agricultural productivity. Weir, (1999) also reported the substantial benefits of education in agricultural productivity.

The majority of the consumer respondents were above grade 12, which indicates the influence of educational level on the choice of nutritional foods. Education also increases awareness of the consumers towards nutritious diets (Hamulka *et al.*, 2018). According to Said (2017) nutritional-based educational program is needed to bring impact towards healthy food behavioral changes.

Table 2: Sex, marital status and educational level of the respondents

Descriptions	Producers		Traders		Consumers	
	Frequency (%)	Total samples (N = 102)	Frequency (%)	Total samples (N = 43)	Frequency (%)	Total samples (N = 137)
Sex						
Male	95.1	97	58.1	25	59.9	82
Female	4.9	5	41.9	18	40.1	55
Marital status						
Single	5.9	6	32.6	14	35.8	49
Married	94.1	96	67.4	29	64.21	88
Education						
No education	23.5	24	7	3	0	0
Read and Write	14.7	15	11.6	5	8.8	12
Up to grade four	33.3	34	16.3	7	5.2	7
Grade five to eight	17.6	18	27.9	12	7.3	10
Grade 9-10	2.9	3	25.6	11	4.4	6
Grade 11-12	2.9	3	7	3	8.8	12
>12 grade	4.9	5	4.7	2	65.7	90

N = sample size

Age and family size of the respondents are illustrated in Figure 2. Relatively young age groups were involved in the marketing of watermelon. This indicates the potential of the watermelon business to accommodate unemployed youth who graduated from the universities. In terms of employment opportunities, the key informants stated that the potential of watermelon to minimize the unemployment rate in the areas is underexploited. Similar results were stated by Kassali *et al* (2015) majority of watermelon traders were young. Adedapo and Kehinde-Fadare (2020) stated that age, family size, and farming experience significantly affect watermelon production.

The survey results indicated that the average family size of watermelon producing farmers, traders and consumers were 6, 4 and 3, respectively. According to Marenya *et al*. (2015), human capital like family size is a key predictor of the ability to enter agricultural markets. Kahan (2013) also reported that large family size has a high chance of managing the

risk of agricultural investment. Similarly, family size significantly influenced watermelon production (Adedapo and Kehinde-Fadare, 2020).

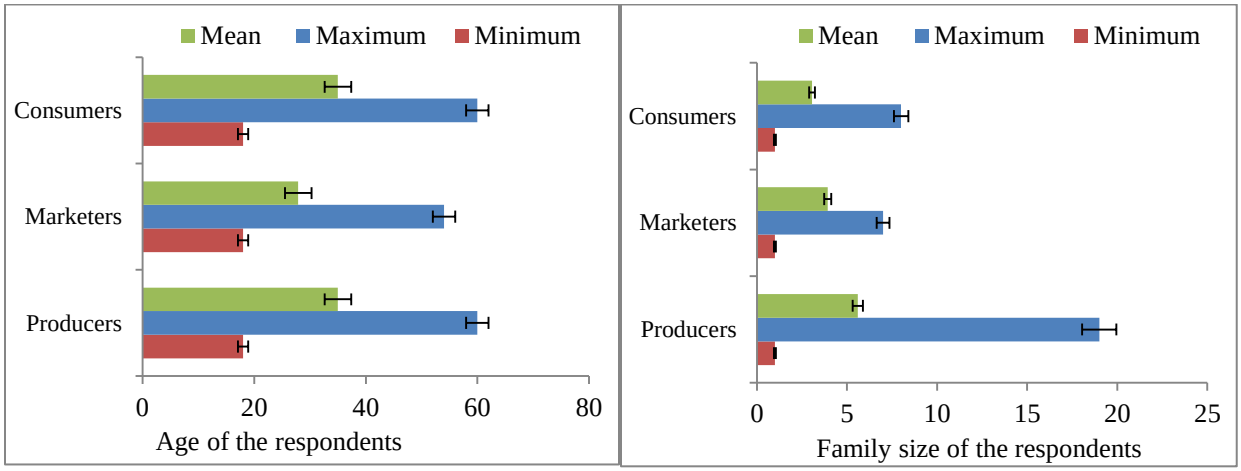

Figure 2: Age (left) and family size (right) of sample household heads

3.2. Farming system and major agronomic practices of watermelon in the survey areas

3.2.1. Farming system and production frequency

According to the survey results three farming systems of watermelon were practiced in the study area; namely, irrigation, rain-fed, and receding systems. About 49% of the respondents practiced the receding farming system at Koka Lake while 43% produced watermelon under irrigation. Both irrigation and rain-fed production systems account only for 5% in the study areas. About 80% of the respondents produced watermelon once a year while 14% produced it twice a year (Figure 3).

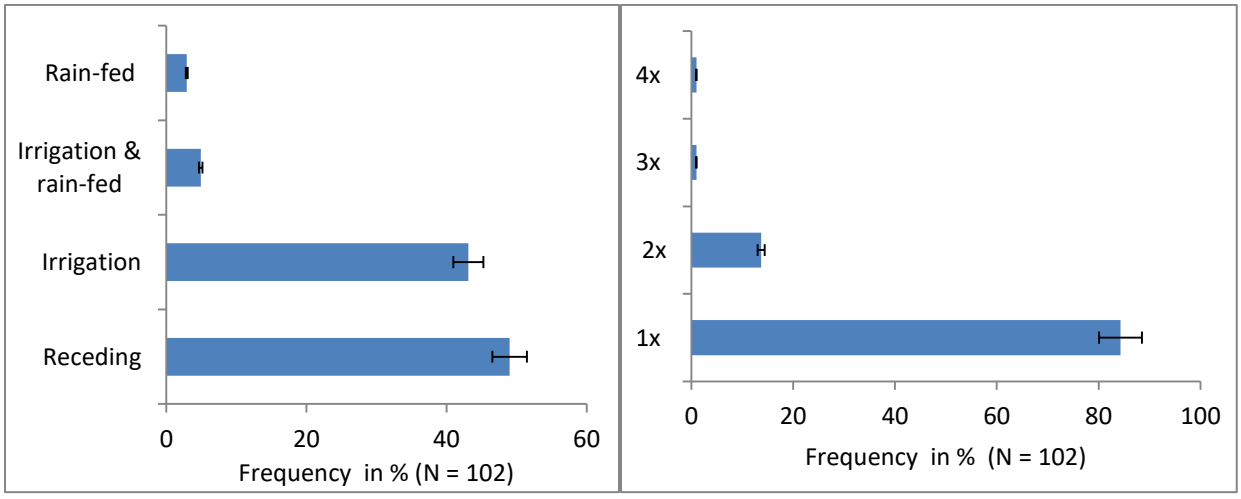

Figure 3: Farming system (left) and watermelon production frequency per year (right) in the study areas

3.2.2. Agronomic practices

Row planting was practiced by all watermelon-producing farmers participated in this study. The mean inter and intra-row spacing used were 1.18 and 1.12 m, respectively. Inter-row spacing ranged from 0.7-2 m, while intra-row spacing ranged from 0.4-2.0 m. Farmers used a mean seed rate of 0. 986 kg ha^{-1}. The highest (Gora-Geremeji kebele) and lowest

(Malima-Berri kebele) seed rates used by farmers were 5.0 kg ad 0.2 kg ha^{-1}, respectively. Watermelon requires moderate amounts of fertilizer as indicated by Hochmuth *et al*. (1998). Farmers in the study area used low rate of DAP fertilizer (50 kg) compared to Urea (200 kg). According to the key informants, powdery mildew, frost, wilt and aphids are the major pests of watermelon in the study areas. Therefore, farmers applied 0.4 to 24 kg and/or liter powder and/or liquid pesticides per hectare for the management of various insect pests and diseases (Figure 4). Farmers also used plastic and "*Satara*" fences around the fields to minimize wind damages.

A seed rate of 5 kg/ha used by farmers for the production of watermelon in the study areas is much higher compared to the recommend seed rate of 1 to 3 kg ha^{-1} in South Africa (DAFF, 2011) and 1.5 to 2.0 kg ha^{-1} world average (FAO, 2020). Therefore, the lowest and highest rates used in the survey areas should be standardized based on the variety and the farming practices in the country.

Crimson Sweet and Sugar Baby are generally the dominant varieties grown in Ethiopia. In the study areas, farmers used Crimson sweet variety as compared to Sugar-baby which is frost sensitive and has less market preference. The dominance of the Crimson sweet variety elsewhere is also reported by USAID (2008). All respondents in the study area practiced the direct sowing method of production. Similar to the current survey results, Adeoye *et al*. (2011) reported that 97% of watermelon-producing farmers in Oyo state of Nigeria practice the direct sowing method of production.

Insect pest and disease damages are serious problem in the study areas. To tackle this problem some farmers used chemicals like Mancozeb 63% WP, Koside-2000, and DDT (Dichloro-Diphenyl-Trichloroethane) for the control of diseases while Diazinol, and Dimethiate-400 for the control of insect pests. However, the majority of the producers did not use chemicals for seed and seedbed treatment to control pests. The majority of the farmers practiced the seed soaking technique with water for 12 to 24 hours before sowing to facilitate germination.

Generally, the agronomic practices implemented for the production of watermelon in the study areas were different among farmers and areas. In this regard, the key informants indicated that production technologies like availability of improved variety, appropriate pest control method, proper plant spacing and fertilizer rates are necessary to enhance yield and quality of watermelon.

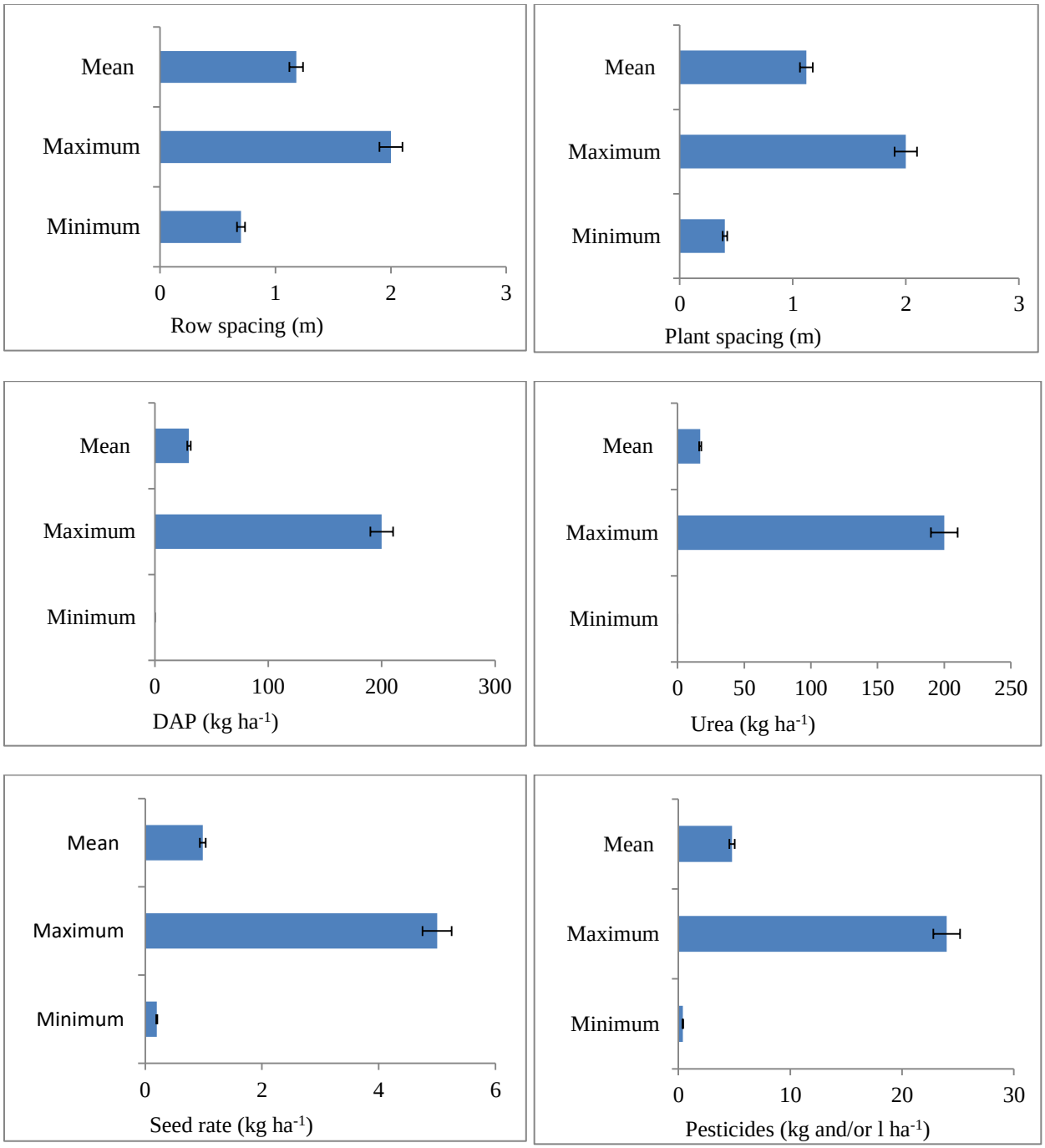

Figure 4: Major agronomic practices of watermelon production in the study areas

3.3. Farmers` experience, farm size, productivity and income generation capacity of watermelon in the study area

The experience of farmers in the study areas in producing watermelon ranged from 1 to 30 years (data not indicated). Although the experience of the farmers in terms of the year was long, the key informants confirmed that their experience in terms of skill and knowledge to produce watermelon is still at a low level. According to Adedapo *et al*. (2020), farming experience influences the production and productivity of watermelon. Adojutelegan *et al*.

(2016) also reported a positive relationship between the year of production experience of framers and the expected yield of watermelon. Similarly, Hien and Tune (2006) observed that the loss of the crop or income reduction of watermelon-producing farmers is mostly associated with a lack of experience in production.

The farm size allocated for watermelon production in the study area ranged from 0.25 to 5 ha (Figure 5). The minimum land was allocated at Doddo-Wodera, Laffissa, and Malima-Berri kebeles in the Bora district with relatively high productivity (40.0 t ha^{-1}) whereas the maximum was at Koka kebele in the Lumme district with relatively low productivity (24.0 t ha^{-1}). This scenario was also reported by Gollin, (2019) where farm size and productivity often have a negative relationship. The technical effectiveness of watermelon producers is reduced significantly as the farm size increased (Sarker, 2017). The extent of farm size allocated for the production of watermelon in the study areas is generally similar to the findings of Adeoye et al. (2011) where 37% of the watermelon farms were below one hectare and about 39% of them had about 1 to 2 hectares in Nigeria.

The mean productivity of watermelon was about 16.2 t ha^{-1} where the minimum and maximum productivity were 2.0 and 40.0 t ha^{-1}, respectively (Figure 5). Although the potential yield of watermelon under ideal conditions is as high as 90 t ha^{-1} (Aziz *et al*., 2009; Baameur *et al*., 2009), the productivity of watermelon in the study area was generally low compared to other countries. In this regard, Adojutelegan *et al* (2016) reported that about 45% of watermelon-producing farmers recorded yield greater than 20 t ha^{-1} in Nigeria. In addition to poor agronomic and irrigation practices, and plant protection, low productivity of watermelon in the study areas is associated with poor fertility status of the soil. The soil of the study area generally is characterized as medium saline while the soil at Doddo-Wodera kebele was highly saline with very low organic carbon and organic matter, and low nitrogen. Moreover, the soil pH is also high ranged from 7.2-7.9 (Table 1). According to Nachtergaele *et al*. (2009) soil pH with the range of 7.2-8.5 is characterized as carbonate rich soil that negatively influences phosphorous and iron availability to plants.

Watermelon-producing farmers in the study area earned an income ranging from 70,711 - 400,000 ETB ha^{-1}. About 47%, 28% and 26% of watermelon-producing household heads categorized the return generated from the crop as medium, high and low, respectively (Figure 5). Generally, the return earned from watermelon production is considerable. Baba *et al*. (2014) also indicated more income of watermelon compared to pepper.

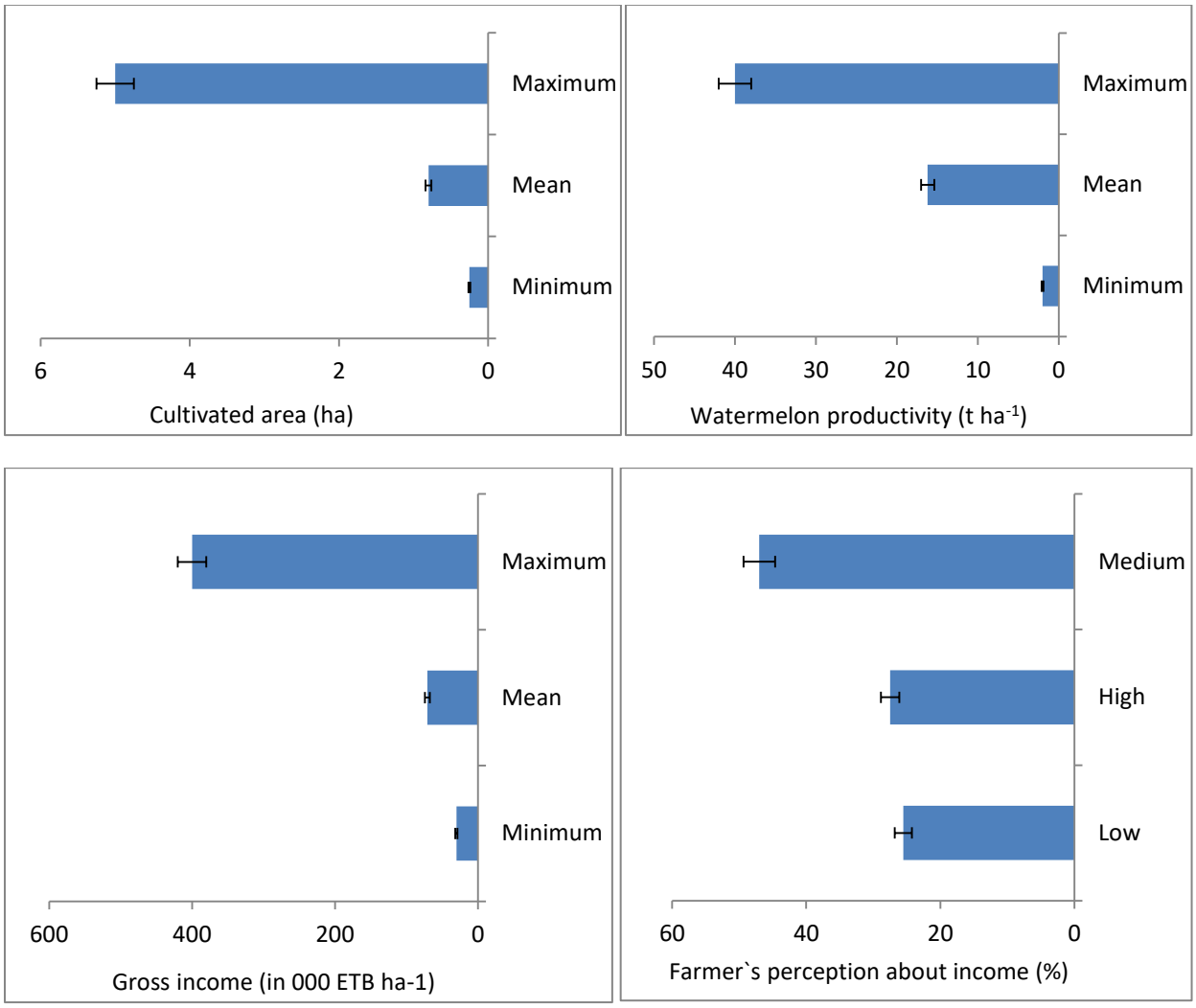

Figure 5: Productivity and income generation capacity of watermelon in the study area

3.4. Opportunities and Constraints of watermelon production

Availability of ample irrigation water sources, low capital requirement, high market demand, proximity to central and roadside markets and relatively longer shelf-life compared to other fruits and vegetables are the existing opportunities for the production of watermelon in the survey areas. About 39-56% of the respondents replied that availability of groundwater, lakes, and receding farming are the main opportunities for the production of watermelon in the study areas. Low levels of capital requirements and high market demand also initiated farmers to produce watermelon in the areas (Figure 6).

Intensive use of available resources is critical for the improvement of production and productivity of crops including watermelon. In this regard, Adedapo and Kehinde-Fadare (2020) reported an increase in watermelon production with the use of existing available resources. Adaption of watermelon in most of the tropical and sub-tropical African countries as potential commercial crop is possible due to its low irrigation water requirement (Dube et al., 2021).

Generally, improper agronomic practices, pest prevalence, lack of input supply, poor infrastructure and market linkage are the major problems that affect the production, and productivity of horticultural crops in Ethiopia (Melkamu *et al.*, 2015; Bezabih and Hadera, 2007). According to the survey results about

54% of the respondents recognized that shortage of inputs such as improved seed, fertilizer, and pesticides are the main major problems in watermelon production. Lack of extension services towards proper agronomic practices and market linkage were also identified by 26 and 14% of the respondents, respectively (Figure 6). The key informants also reported that neither the GO nor NGOs give due attentions for watermelon production in the area. Accordingly, they called watermelon as an "orphan crop".

Low attention given to watermelon in Ethiopia is also underlined by Mekonnen (2014) where the author reported poor extension services towards production technique and marketing of the crop. Similar to the present study, lack of technology and capital for large-scale production, lack of improved variety, limited access to land, high input costs, the prevalence of diseases and insect pests, poor market linkage, lack of transportation, and storage services and market price fluctuation were identified as major constraints of watermelon production in Nigeria (Baba *et al*., 2014; Adojutelegan *et al*., 2016; Adedapo and Kehinde-Fadare, 2020). Lack of improved varieties, poor production system, perishability nature of the fruit and lack of harvesting, and postharvest technologies hamper watermelon production (Dube *et al*., 2021). On the other hand, Odinwa *et al*. (2015) reported that inadequate information about watermelon enterprises such as production, processing, marketing, economic profitability and high cost of transportation are the major constraints of watermelon adoption.

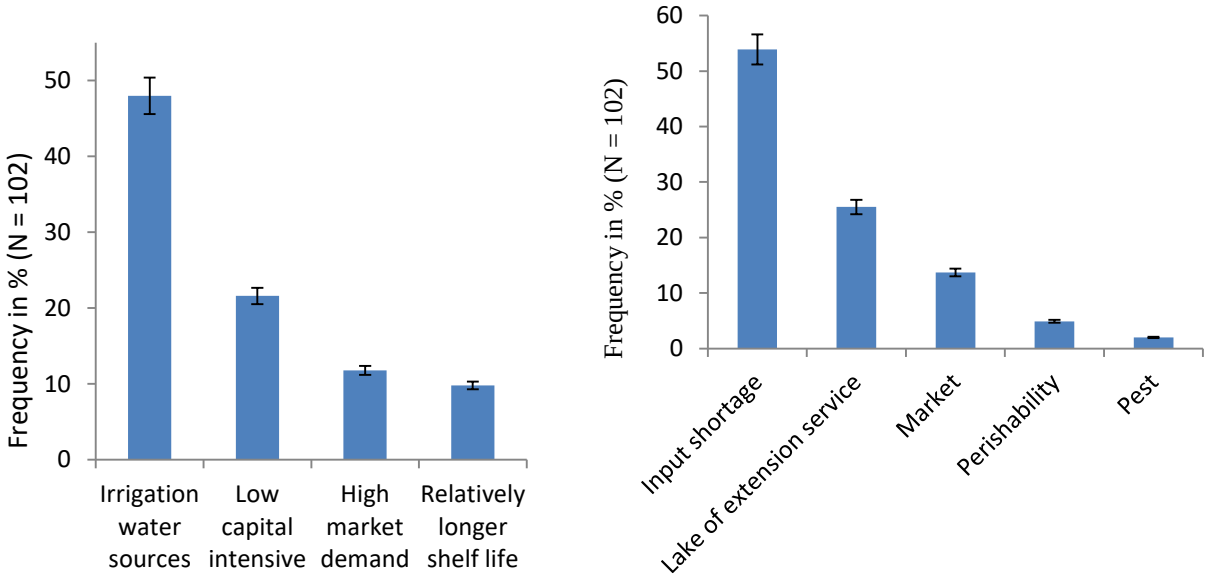

Figure 6: Opportunities (left) and constraints (right) of watermelon production in the study areas

3.5. Demand and supply of watermelon market

Change in the price of watermelon is associated with the supply fluctuation resulted from weather conditions often makes the watermelon market speculative (Hochmuth et al. 1998). The perusal data presented in Table 3 indicates the influence of production season on watermelon marketing. About 77% of the traders responded that from January to March there is relatively more watermelon supply than the demand which leads to the reduction of unit price. On the other hand, about 67.4% of the traders recognized a high demand than supply of watermelon from July to September leading to increased unit price. From January to March, the traders perceived a balanced supply and demand of watermelon in the study area. The common watermelon marketing system practiced in the study area was a double transaction where farmers sell their products to the brokers at the farm gate price and brokers to traders

which is similar to the marketing system reported by Mekonen (2014).

Table 3: Supply and demand of watermelon market

Descriptions	Percentage	Frequency (N = 43)
Supply is greater than demand		
January to March	76.7	33
April to June	4.7	2
July-September	7	3
October to December	11.6	5
Supply is less than demand		
April to June	27.9	12
July to September	67.4	29
October to December	4.7	2
No specific date	2.3	1
Supply is equal to demand		
January to March	18.6	8
April to June	58.1	25
October to December	23.3	10

3.6. Variety and fruit size preference of watermelon market

The data presented in Table 4 indicate that more than 60% of the traders perceived that the degree of return generated from watermelon marketing is categorized as medium while 37% perceived it as low compared to other vegetable crops. More than 65% of the traders confirmed that the bulkiness of watermelon fruits affects the marketing processes while 35% perceived no effect of bulkiness on the marketing activities.

About 56% of the traders realized the presence of consumers` preference towards variety and fruit size while 35% of them did not. The majority of their customers preferred the Crimson (strip type) variety because of its storability, good taste and the positive perception to the green and white stripes of the fruits. In terms of fruit size, most customers (63%) preferred medium-sized fruits which are mostly associated with affordability, ease of handling and perishability. According to the information obtained from the traders, big fruits are mostly sold to hotels and pizzerias (Table 4). In line with the results of the present study Adeoye and Lawrence (2012) reported that about 66% of consumers preferred medium-sized fruits in the urban area of Nigeria. The choice in fruit size is determined by the family size of the consumers (Adeoye and Lawrence, 2012). Similarly, Kassali *et al*. (2015) reported the presence of price discrimination and fruit size preference in Nigeria`s watermelon market. The size of the fruit, the sugar content and the color of the pulp are the major fruit traits that guide the choice of the consumers (Chogou *et al*., 2019). Generally, consumer preference may direct the breeding programs toward the preferred quality attributes and storability of watermelons (Adeoye and Lawrence, 2012).

Table 4: Return potential and preference of watermelon market

Descriptions	Percent	Frequency (N=43)	Descriptions	Percent	Frequency (N=43)
Market return potential			Size preference:		
Low	37.2	16	Small	4.7	2
Medium	60.5	26	Medium	62.8	27
High	2.3	1	Big	32.6	14
Bulkiness affects the market			Reasons for preference:		
Yes	65.1	28	Handling	9.3	4
No	34.9	15	Quality	23.3	10
Consumer preference			Perishability	9.3	4
Yes	55.8	24	Mass consumption	25.6	11
No	44.2	19	Affordability	32.6	14
Variety type					
Crimson	37.2	16			
Sugar baby	18.6	8			
Other (hybrid)	11.6	5			
Any variety	32.6	14			

3.7. Intention and habit of watermelon consumption

Watermelon consumption of the people in the study area ranged from 1 to 30 years. The consumption was directly associated with different reasons. About 55% of the consumers consumed watermelon because of its health benefits like the proper functioning of the kidney and urination (Table 5). Moreover, some consumers perceive that watermelon enhances the performance of good sexual intercourse. In this regard, Munglue et al (2014) implicated that watermelon flesh extract increased the general mating behavior of male rats.

The people who purchased watermelon from farms and roadside markets (24%) replayed that they consumed it as water sources to alleviate body dehydration while others (18%) consume it like any other fruit without any concrete reasons. Based on the survey data, the frequency of watermelon consumption varies according to the living standard and educational level. The majority of consumers (62%) had no specific time or occasion for watermelon consumption while some of the respondents (25%) consume it on a weekly basis and monthly basis (10%) (Table 5). These results are in line with the findings of Adeoye and Lawrence (2012) that 29.4 % of consumers in the urban area of Oyo State of Nigeria purchased watermelon once a week. Generally, the affordability (45%) and bulkiness (53%) of the fruit negatively influenced the extent of watermelon consumption in the study area.

The majority of the consumers prefer medium-sized fruits (46%) of Crimson sweet (strip-type) variety where high price and bulkiness contributed to low and no frequent consumption of watermelon in the study area. About 53% of consumer's choices were based on the test (flavor) as a quality parameter. On the other hand, 46% of the consumer's choices were based on major quality parameters such as flavor, flesh color and crispness as a whole (Table 5). In most parts of the world in general, seedless, smaller and pre-cut watermelons provide the consumers with more convenience (Evans, 2008).

Table 5: General information about watermelon consumers

Descriptions	Percent (%)	Frequency (N = 137)	Descriptions	Percent (%)	Frequency (N=137)	Descriptions	Percent (%)	Frequency (N=137)
Why do you consume watermelon			Is it an affordable commodity:			Maturity index		
Health benefits	55.4	69	Yes	60.6	83	Fruit size	6.6	9
As any fruit	18.2	25	No	39.4	54	Fruit color	10.2	14
As water source	24.1	33	Bulkiness			Sound	14.6	20
No, any reason	7.3	10	Yes	53.3	73	Other (test and seed)	7.3	10
Frequency of consumption:			No	46.7	64	All used	61.3	84
Weekly	25	37	Fruit size preference			For how long do you consume watermelon (year)		
Monthly	9.5	13	<4 kg	19	26	Minimum	1	-
Special Occasion	1.5	2	4-5.5 kg	46	63	Maximum	30	-
No specific time	62	85	>5.5 kg	10.9	15	Mean	7.9	-
Variety preference			Any size	24.1	33			
Strip	60.6	83	Quality attributes					
Black	20.4	28	Flesh color	0.7	1			
Other hybrids	2.2	3	Test (flavor)	52.6	72			
Any type	16.8	23	Texture (crispness)	0.7	1			

3.8. Marketing channel of watermelon

The marketing channel describes the distribution of watermelon from the area of production to the area of consumption. Based on the survey result, two distinct marketing channels of watermelon are identified in Ethiopia as depicted in Figure 7. In the first channel, watermelon are collected from the production area and transported to the central market, the so-called "Atikilt Tera", in Addis Ababa and distributed to the rest parts of the country, which is the main route where the majority of the produce has been distributed. In the second channel, watermelon fruits are collected from the production area and distributed to the area of consumption without touching the central market in Addis Ababa.

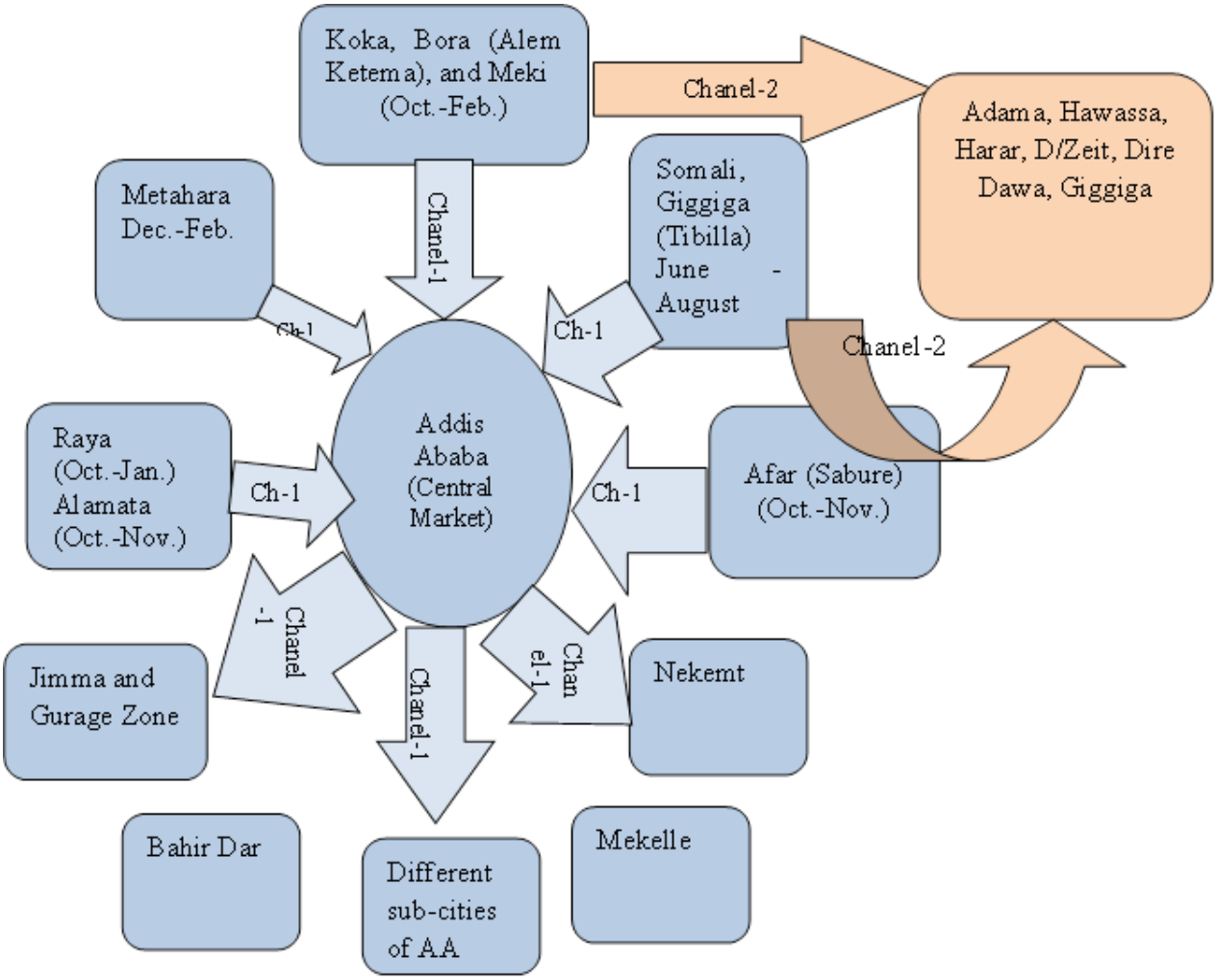

Figure 7: Major marketing channels of watermelon in Ethiopia

4. Conclusion

Watermelon is an important economic vegetable crop in the study area. A considerable number of female households and youth are engaged in the value chain, especially in the marketing of watermelon, which is a good opportunity for income generation. Although the crop is recently introduced, farmers allocated a farm land up to 5 hectares for the production of watermelon. It implies watermelon farming is lucrative. There was variability in the watermelon yield and income generation among farmers, which is probably associated with the implemented agronomic practices and the knowledge and skills of farmers in producing watermelon. Such conditions call for extension agents and scientific researches that help to

optimize the production practices such as spacing, fertilizer rate, time and method of fertilizer application, and pest management options thereby enhancing the production, and productivity of watermelon in the areas. Moreover, as the consumers mostly prefer Ice-box type of watermelon (4-5.5 kg), introducing agronomic practices that help minimizing the fruit size and bulkiness with desirable quality attributes are necessary

Using the residual moisture following the receding of Lake Koka was the dominant farming system in the study area. Irrigation farming system should also be intensively used for production of the crop. Farmers in the study area are dependent on imported seeds. This scenario invites entrepreneur and seed-producing companies to engage on the production of seeds of open-pollinated varieties. Shortage of input and lack of extension services, inappropriate agronomic practices, and occurrence of pests are the major bottlenecks of watermelon production, where training and extension services as well as the development of production manual are vital to enhance the production and productivity of watermelon. Stagger planting by using receding, irrigation and rain-fed farming systems is vital to supply watermelon year-round. Availability of ample water sources, low capital intensive, high demand in the market, the proximity of the areas to central and roadside markets and relatively longer shelf-life as compared to other fresh fruit and vegetable crops are the opportunities for watermelon in the areas.

Based on the results of the present study, watermelon is a good crop candidate for commercial farming with relatively large allocated production land in the study area and in the other parts of the country including in the Northwest Ethiopia.

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Data availability statement

Data will be made available upon request.

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Conflicts of interest

The authors declared that there is no conflict of interest.

References

Adedapo, O., and Kehinde-Fadare, F. (2020). Effects of watermelon production on the livelihoods of smallholder farmers in Ekiti State, Nigeria. *Stem Cell*, 151(1): 5–13. http://dx.doi.org/10.4038/rjs.v10i2.80

Adeoye B.I., and Balogun, O.L. (2012). Consumer preference for watermelon varieties inurban environment of Ibadan Metropolis, Oyo State, Nigeria. *Food* 6(1): 93-96.

Adeoye, B., Olajide-Taiwo, F.B., Adebisi-Adelani, O. Usman, M., and Badmus, A. (2011). Economic analysis of watermelon based production system in Oyo State, Nigeria. *ARPN Journal* of *Agricultural and Biological Science* 6(7): 53–59.

Adojutelegan, T. Adereti, O., Makanju, T.S., and Olorunfemi, D. (2016). Analysis of factors affecting watermelon production in Ekiti State, Nigeria. *Science, Technology and Arts Research Journal* 4(2): 324.

Afolabi, J. (2004). An evaluation of beef marketing in Osun State, Nigeria. *Journal of Agriculture, Forestry and Fisheries* 5(2): 29–32.

Alemayehu, M., Tesafa. F., Bizuayehu, S., and Ayele, B. (2015). Amhara Region Horticulture Development Strategy, Bahir Dar, Ethiopia. https://www.researchgate.net/publication/318876775

Alfa-Nla, A. (2014). Economic analysis of watermelon (citrillus lanatus) production in selected local government areas of kano state, Nigeria. Ahmadu Bello University, Zaria, Nigeria.

Arifullah, A. (2020). Managing farm-centric risks in production at the flood-prone locations of Khyber Pakhtunkhwa, Pakistan. Swedish University of Agricultural Sciences.

Aziz, T., Hartz, T., Turini, E., Natwick, E., Takele, J., Aguiar, M., and Cantwell, M. (2009).

Watermelon production in California. USA, California.

Baba, M., Yelwa, J.M., Yakubu, G., and Sanchi, D. (2014). Comparative profitability analysis of watermelon and pepper production in Danko-Wasagu local government area of Kebbi State, Nigeria. *Review of Knowledge Economy* 1(2): 39–47.

Bezabih Emana and Hadera Gebremedhin. (2007). Constraints and opportunities of horticulture production and marketing in eastern Ethiopia. Dry Land Coordination Group.

Chogou, R., Assogba, H., Degbey, E., Abokini, E., and Achigan, D. (2019). Market structure and performance of watermelon (*Citrullus lanatus*) in Benin. *Scientific African* 3(48): 1–9. https://doi.org/10.1016/j.sciaf.2019.e00048.

DAFF (Department Agriculture, Forestry and Fisheries) (2011). Production Guidelines of Watermelon (*Citrullus lanatus*). Pretoria, South Africa.

Dube, J., Ddamulira, G., and Maphosa, M. (2021). Watermelon production in Africa: challenges and opportunities. *International Journal of Vegetable Science*, *27*(3): 211–219. https://doi.org/10.1080/19315260.2020.1716128

Ekerete, B., and Asa, A. (2014). Constraints to Watermelon Marketing in Uyo Metropolis of Akwa Ibom State, Nigeria. *Journal of Agriculture and Environmental Sciences* 3(4): 63–69.

Evans, B., and Nelson, G. (2008). Consumer Preferences for Watermelons: A Conjoint Analysis. Auburn University, Alabama.

FAO. (2019). Watermelon Crop Information. http://www.fao.org/land-water/databases-and-software/crop-information/watermelon/en/.

FAO. (2020). Crop production manual. A guide to fruit and vegetable production in the Federated States of Micronesia.

Gichimu, M., Owuor, O., and Dida, M. (2014). Yield of three commercial watermelon cultivars in Kenya. *Africa Journal of Horticultural Science*. 2010 (3): 24–33.

Gollin, D. (2019). Farm size and productivity. Lessons from recent literature. IFAD research series.

Hamulka, J., Wadolowska, L., Hoffmann, M., Kowalkowska, J., and Gutkowska K. (2018). Effect of an education program on nutrition knowledge, attitudes toward nutrition, diet quality, lifestyle, and body composition in Polish teenagers. The ABC of Healthy Eating Project: Design, Protocol, and Methodology. *Nutrients* 10(10):1-23.

Hien, M., and Tung, T. (2006). Analysis of watermelon value chain in Long an Province. http://www.sme-tz.org.vn/Download/Component

Hochmuth, J. Stall, W.M., Hewitt, D., and Ruppert, C. (1998). Alternative opportunities for small farms: Watermelon production review. RF-AC013.

Hochmuth J. Hanlon A., and Cornell, J. (1993). Watermelon phosphorus requirements in soils with low Mehlich-I-extractable phosphorus. *HortScience* 28(6): 630–32.

Kahan, D. (2013). Farm management extension guide managing risks in farming: Farm Management Extension Guide. https://www.google.com/url.

Kainga, P. (2013). Marketing margin and determinants of net return of watermelon marketing in Yenagoa metropolis of Bayelsa state, Nigeria. *Journal of Experimental Biology and Agricultural Sciences*, 1(4): 241–47.

Kassali, R., Aremu, J., and Shittu, A. (2015). An economic analysis of watermelon marketing in Oyo State, Nigeria. *PAT* 11(2): 43–52.

Kothari, R. (2004). Research Methodology; Methods and Techniques. Second rev. New Age International. http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf.

Marenya, P., Menale, K., Moti, J., and Dil, R. (2015). Does gender of the household head explain smallholder farmers maize market positions ? Evidence from Ethiopia. *Agriculture in an interconnected world*, 8(14): 1–40.

Mekonnenm, F. (2014). Watermelons a Great Opportunity for Ethiopian Producers. LIVES Project Report.

Munglue, P., Sajeera, K., and Pakanit, K. (2014). Effect of watermelon (Citrullus Lanatus) flesh extract on sexual behavior of male rats. *Chiang Mai University Journal of Natural Sciences* 13(1): 519–27.

Nachtergaele, F., Harrij, van V., ad Luc, V. (2009). Harmonized world soil database. FAO, Rome.

Namdari, M. (2011). Energy use and cost analysis of watermelon production under different farming technologies in Iran. *International Journal of Environmental Sciences* 1(6): 1144–53.

Odinwa, A., Isife, B.I., and Albert, O. (2015). Analysis of the adoption rates of watermelon enterprise in Ogba / Egbema / Ndoni local government area of rivers state, Nigeria. *Singaporean Journal of Business Economics and Management Studies* 4(9): 20–28.

Oduro-Ofori, E., Prince, A., and Naa, E.A. (2014). Effects of education on the agricultural productivity of farmers in Offinso Municipality. *International Journal of Development Research* 4(9): 1951–60.

Otunaiya, O., and Adedeji, A. (2014). Technical efficiency of watermelon (*Citrullus lanatus*) production in Ogun state, Nigeria. International *Journal of Applied Agriculture and Apiculture Research* 10 (1&2): 44–53.

Parmar, N., Polara, D., and Viradiya, R.R. (2013). Effect of mulching material on growth, yield and quality of watermelon (*Citrullus lanatus* Thunb) Cv. Kiran. *Universal Journal of Agriculture Research* 1(2): 30–34.

Popescu, A. (2012). Research on Romania's watermelon and melon market. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* 12(4): 45–54.

Raidimi, N. (2015). The roles and activities of women in the six selected agricultural projects in Thulamela local municipality of Vhembe district municipality in the Limpopo province. *South African Journal of Agricultural Extension* 42(2): 10–23.

Rayasawath, C. (2018). Factors affecting the household succession in agricultural occupation in Nakhon Ratchasima Province, Thailand. Agriculture (Switzerland) 8(7):1-14.

Said. N. (2017). Impact of the nutritional educational program to the healthy food behaviour, knowledge, attitude and environment for Obese Children. *Environment-Behaviour Proceedings Journal*, 2(5):1-7. http://dx.doi.org/10.21834/e-bpj.v2i5.420.

Sarker, B. (2017). Technical efficiency, determinants and risks of watermelon production in Bangladesh. *IOSR Journal of Economics and Finance*, 08(02): 51–59.

Ukwuaba, I., Charles, F., Ugwuoke, A., and Kehinde P.A. (2018). Socio-economic and institutional determinants of watermelon marketing in Enugu State Nigeria. *Journal of Agricultural Extension*, 22(3): 161–73.

Urrutia, D., Willy, G., and Rolan, M. (2014). Optimization of the productions of watermelon and melon in Candaba, Pampanga. *Countryside Development Research Journal*, 2(01): 25–32.

USAID (United States Agency for International Development) (2008). Commodity Development Plan: Watermelon. Albania, USA.

Webber, C., James, S., Penelope, P. (2019). Organic watermelon production systems: Varieties and weed Control. *HortScience* 41(4): 1034C – 1034.

Weir, S. (1999). The effects of education on farmer productivity in rural Ethiopia. Centre for the Study of African Economies Department of Economics, University of Oxford: pp 50.

Yamane, T. (1965). Statistics, an Introductory Analysis. *Journal of the American Statistical Association*, 60(310): 678.

Zhou, W. (2011). Demand for Watermelon and Application of AIDS Models. https://api.semanticscholar.org/CorpusID:74233963